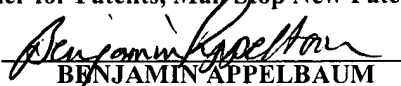


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By: 
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**APPLICATION FOR LETTERS PATENT OF
THE UNITED STATES**

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FRED BUCHANAN**

**TITLE OF INVENTION: SKATEBOARD AND METHOD OF
MANUFACTURING**

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Skateboard and Method of Manufacturing

Field of the Invention.

The present invention relates to skateboards. In particular, the present invention relates to a skateboard whose deck is manufactured by laminating layers of carbon fiber together, over a single layer of fiberglass, under heat and pressure, with the resulting skateboard deck produced in this manner having properties comparable to those of skateboard decks manufactured from wood.

Background of the Invention.

An embodiment of the present invention is a skateboard deck manufactured by laminating layers of carbon fiber together under heat and vacuum, over a single layer of fiberglass, and the skateboard deck produced in this manner has properties at least comparable to those of skateboard decks manufactured from woods. The earliest skateboards had decks that were made of wood, but plastics, fiberglass, KEVLAR® (Registered trademark of E.I. DuPont de Nemours Co., Wilmington, DE), and metals have also been used to form the deck. These materials have different characteristics and properties, which affect the performance of the skateboard. For example, a longboard (which we will define here as a skateboard having a distance of at least 26 inches between the front and rear skateboard wheels) is generally preferred by skateboarders when engaging in downhill skateboarding activities, while a small board, or "Standard" size skateboard, generally having an overall length of between approximately 30 inches to approximately 33 inches, is more commonly preferred when skateboarding on ramps.

A review of prior art discloses a number of patents which describe skateboards and aspects of their manufacture.

Western (U.S. Pat. No. 6,059,307) discloses a method of

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1 manufacturing a skateboard deck using a core of wood plies
2 surrounded by a cover comprising a pregnable cloth, such as
3 fiberglass cloth or carbon fiber cloth. One embodiment uses a
4 sheet of pregnable cloth placed over the upper surface and lower
5 surface of the deck. A second sheet of pregnable cloth is placed
6 over the first sheet, with the threads running at a 45 degree angle
7 to each other.

8
9 Peart et al. (U.S. Pat. No. 5,716,562) discloses a method for
10 making an injection molded, foamed, composite material skateboard.
11 The skateboard body is formed of a composite material including a
12 foamed structural plastic mass including plural, elongate strands
13 of carbon fiber material distributed within the confines of the
14 mass; the carbon fiber strands contribute within the range of about
15 5% to about 70% of the total weight of the mass. The skateboard
16 body is formed by injection molding using a thermoplastic such as
17 nylon, polypropylene and polyethylene.

18
19 Bert (U.S. Pat. No. 6,527,284 B2) discloses a skateboard deck
20 comprising a plurality of layers of wood plies; the deck plies
21 preferably being made from a wood such as maple. The deck further
22 includes reinforcement members, positioned either at the front of
23 the deck, in the area where the front wheels are fixed, in the rear
24 where the rear wheels are fixed, or on the periphery of the deck,
25 with the reinforcement being inserted between the upper surface
26 layer and the lower surface layer.

27
28 In U.S. Pat. No. 6,520,518 B2 Lo discloses an aluminum
29 skateboard including an upper plate and a lower plate, with
30 reinforcing ribs being integrally formed on the inner wall of each
31 plate.

32
33 Madrid (U.S. Pat. No. 6,460,868 B2) discloses a corrugated
34 wooden skateboard deck and the use of a high density polyethylene
35 mold in which to form the corrugations within the deck. The deck

1 is formed from a plurality of wooden plies, interspersed with a
2 bonding agent, and formed within the mold under conditions of
3 pressure until the bonding agent sets.
4

5 In U.S. Pat. No. 6,435,558 B2 Osawa discloses a roller ski
6 board formed from a light material, such as a synthetic resin,
7 glass fiber and light metal or light compound material such as a
8 plywood, etc.
9

10 Kay (U.S. Pat. No. 6,419,248 B1) discloses a skateboard having
11 a deck comprising an upper and a lower platform separated by a
12 plurality of journaled bearings, allowing for control of the
13 skateboard.
14

15 In U.S. Pat. No. 6,293,571 B1 Wen discloses a skateboard
16 comprising an elongated body with a hollow core and a plurality of
17 reinforcing ribs within the deck. The elongated body, reinforcing
18 ribs and the strengthened frame are integrally made of a moldable
19 material, such as aluminum alloy.
20

21 Wilson (U.S. Pat. Nos. 6,273,440 B1, "the '440 patent" and
22 6,203,037) discloses a metal sports board, manufactured from
23 aluminum. In the '440 patent, the metal board also includes one or
24 more longitudinally elongated cavity-forming sections which may be
25 filled with an appropriate light weight filler material such as a
26 foamed plastic, a wood or wood composite material, or an inflatable
27 bladder to aid in the strength and/or manufacturing of the metal
28 sports board.
29

30 In U.S. Pat. No. 6,214,142 B1 Saputo discloses a method of
31 making a skateboard deck using multiple layers of wood veneers.
32 The method uses several layers of wood veneers in a hydraulic
33 press, followed by shaping them on a CNC (computer numerical
34 control) device, adding truck mounting inserts and an additional
35 veneer layer.

1
2 In U.S. Pat. No. 5,649,717 Augustine et al. disclose a
3 snowboard comprising a base of high density polyethylene, over
4 which a layer of cloth, particularly hemp, is applied, and to which
5 layers of fiberglass and a veneer panel are applied. A core made
6 of wood, metal, KEVLAR® (Registered trademark of E.I. DuPont de
7 Nemours Co., Wilmington, DE) or other resilient material with metal
8 plates or inserts is encapsulated with a layer of fiberglass. The
9 core is placed over the veneer layer, and a final layer of cloth
10 material is used to surround the base and core.

11
12 Parten (U.S. Pat. No. 4,921,513) discloses a method for making
13 a wooden skateboard, in which a printed label is applied to the
14 board lower surface by an adhesive, so that the outer periphery of
15 the label matches the contours of the board's lower surface.

16
17 In U.S. Pat. No. 4,337,963 Stevenson discloses a skateboard
18 wherein the skateboard pieces can be formed from plastics such as
19 polypropylene, polyethylene, polycarbonate, or other suitable
20 plastic which can be injection molded.

21
22 Moore (U.S. Pat. No. 4,95,656) discloses a skateboard having
23 flexible sides, the board comprising a spine of laminated hardwoods
24 encased between layers of fiberglass.

25
26 Smith (U.S. Pat. No. 6,182,989 B1) discloses a skateboard
27 having laminations which are selected from at least two or more
28 materials, one material being wood and the other material being
29 non-wood. The non-wood material can be a layer of carbon fiber or
30 fiberglass.

31
32 Hanson (U.S. Pat. No. 6,386,561 B1) discloses a laminated
33 skateboard comprising a wood core with fiberglass layers.

34
35 Thus, while others described skateboard decks made from wood,

1 wood laminates, or wood with a carbon fibre layer, no skateboard
2 decks are described in which the entire deck is manufactured from
3 carbon fiber, or with multiple layers of carbon fiber plus a single
4 layer of fiberglass as a base. An embodiment of the present
5 invention is a skateboard whose deck is manufactured from multiple
6 layers of carbon fiber, and which has strength that is comparable
7 to wooden skateboard decks. Embodiments of skateboard decks of the
8 present invention are very durable, unlike wooden skateboard decks
9 which frequently break during use. The performance of embodiments
10 of skateboard decks of the present invention differs from that of
11 wooden skateboard decks, such that embodiments of skateboards made
12 using the present invention flex more than wooden skateboards, they
13 do not slide when one is taking corners, because it is theorized
14 that they create a greater downward force when cornering thereby
15 minimizing the sideward forces that would cause sliding on corners,
16 than do wooden skateboard decks. Embodiments of the skateboard
17 decks of the present invention can be manufactured using either a
18 manual layup process or a thermoforming process, both of which are
19 also described herein.

1 Brief Summary of The Invention.

2
3 An object of the present invention is to provide a skateboard
4 deck manufactured from carbon fiber.

5
6 Another object of the present invention is to provide a
7 skateboard deck manufactured from carbon fiber and with a layer of
8 fiberglass.

9
10 Another object of the present invention is to provide a method
11 of manufacturing a skateboard deck from a durable material such as
12 carbon fiber.

13
14 Another object of the present invention is to produce a
15 skateboard deck that is durable in use.

16
17 Embodiments of the present invention are a laminated
18 skateboard deck, formed using either a hand layup process or a
19 thermoforming process. Embodiments of the skateboard deck
20 comprises a plurality of layers of graphite cloth alternating with
21 a plurality of layers of a laminating resin. The deck is formed
22 after treating the layers of material for approximately 45 minutes
23 under a vacuum at a temperature ranging from ambient temperature to
24 approximately 85 degrees F. Using the thermoforming process,
25 multiple layers of graphite cloth containing a laminating resin
26 ("pre-preg" material) are inserted into a mold, and subjected to a
27 temperature ranging from approximately 200 to approximately 600
28 degrees F for a time period ranging from approximately 1 hour to
29 approximately 6 hours under a vacuum. An additional lower layer of
30 fiberglass, which can become the deck bottom, may be used in both
31 processes. The laminated skateboard deck has properties that are
32 at least comparable to those of wooden skateboard decks.

1 Description of the Several Views of the Drawing.
2 Fig. 1 is a perspective view of a skateboard embodiment of the
3 present invention.
4 Fig. 2 is a top plan view of two embodiments of the present
5 invention, Fig. 2A illustrating the longboard embodiment, and Fig.
6 2B illustrating the smallboard embodiment.
7 Fig. 3 illustrates the formation of a laminated skateboard deck.
8 Fig. 4 illustrates the fiber pattern of a sheet of graphite cloth.
9

1 Detailed Description of the Invention.

2
3 An embodiment of the present invention is a skateboard 10
4 which comprises a skateboard deck 20, a plurality of trucks 40, and
5 a plurality of wheels 60 connected to the trucks (Fig. 1). The
6 deck 20 is attached to the trucks 40 by means of fasteners 30. The
7 fasteners 30 can be bolts and nuts, screws, rivets, or other
8 suitable fasteners known to those skilled in the art. Adhesives
9 could also be used. Generally, the fastener used is a nut and
10 bolt, to form a secure connection with the deck.

11
12 For purposes of the present specification, the terms "carbon
13 fiber" and "graphite cloth" will be used interchangeably to refer
14 to the same material.

15
16 The deck 20 is made from a plurality of layers of graphite
17 cloth 24a-24xx where xx is the number of layers of graphite cloth
18 used. Interspersed between the layers of graphite cloth 24a-24xx
19 is a plurality of layers of a laminating resin 22a-24xx, where xx
20 is the number of layers of laminating resin. Generally, xx is
21 identical for both the number of layers of graphite cloth 24 and
22 the number of layers of the laminating resin 22 (Fig. 3).

23
24 Deck 20 further comprises a main deck region 26 and deck 20 is
25 separated from trucks 40 by standoffs 28.

26
27 Fig. 2 illustrates two embodiments of a skateboard deck
28 produced using the methods described below. Fig. 2A and 2B
29 represent embodiments referred to herein as a "longboard", and
30 "small board", respectively. As seen in a top plan view, the
31 boards differ in their overall configuration, with the length of
32 the longboard being between approximately 42 inches to
33 approximately 48 inches with a width ranging from approximately 7
34 inches to approximately 10 inches. The general dimensions of the

1 small board are approximately 30 inches to approximately 33 inches
2 length with a width ranging from approximately 7 to approximately
3 8 inches. A mid-board, that is, one having a length that is
4 intermediate between the short and the long board, generally has a
5 width ranging from approximately 7 to approximately 8.5 inches (not
6 shown). However, the widths of any particular skateboard may vary
7 from those described, depending upon the final shape of the
8 skateboard, and the dimensions described herein are for purposes of
9 example only, and not intended as a limitation. The dimensions of
10 the trucks of the two boards (shown in the figures in phantom) are
11 slightly different, but will not be described further.
12

13 The decks of the two skateboards differ, inasmuch as that of
14 the longboard is thicker, with its main deck comprising 26 layers
15 each of the graphite cloth and laminating resin, and the small
16 board main deck comprises 21 layers each of graphite cloth and
17 laminating resin. The standoffs 28 of both boards comprise 12
18 layers of each material, i.e., 12 layers of graphite cloth and 12
19 layers of laminating resin.
20

21 A layer of fiberglass 50 may also be used in the manufacture
22 of these skateboard deck embodiments 20. Referring to Fig. 3, this
23 additional layer is formed by sandwiching the fiberglass 50 between
24 two layers of laminating resin 22a and 22b, and using the
25 fiberglass layer as the base layer onto which the remainder of the
26 skateboard deck is built. In so doing, the fiberglass layer
27 becomes the bottom surface of the finished deck. The fiberglass
28 layer provides a more finished appearance to the skateboard deck.
29

30 Embodiments of the present invention are made using what is
31 referred to as a hand layup process.

Hand Layup Process for Skateboard Decks.

In this process, a bulk piece of graphite cloth, having a thickness ranging of approximately 0.010 inches, with a tolerance of ± 0.005 inches, is cut into a plurality of pieces of a specified size, which is slightly greater than the intended final dimension of the finished product. Then a layer of a laminating resin is applied to a first layer of the graphite cloth, and the excess resin is removed with a squeegee or similar device, to provide a layer of laminating resin having a thickness approximately equal to the thickness of the underlying graphite cloth.

A second layer of graphite cloth is applied to the combination of graphite cloth-laminating resin, and the process of adding laminating resin, removing excess laminating resin, and adding graphite cloth is repeated until a sandwich which will become the skateboard deck of a specified thickness has been achieved.

Generally, this can be done either by manual or machine application of a squeegee or similar device, or by the application of a vacuum to the graphite fiber-laminating resin sandwich, to extract all excess air from the laminate.

After the sandwich has been formed and the excess resin is removed, this cloth-resin sandwich is subjected to a vacuum of approximately 90 psi (pounds per square inch) to approximately 125 psi at a temperature ranging from approximately 75 degrees F to approximately 85 degrees F (ambient temperature), for generally approximately 45 minutes.

After the skateboard deck has been formed, excess graphite cloth and resin are removed to trim the skateboard deck to a desired shape, the skateboard deck sanded, and one or more coats of a finish, such as paint, varnish or the like is applied to provide

1 a finished appearance. The trucks and wheels, and any other
2 accessories needed for the skateboard, are then applied.

3
4 The fiber directions are alternated with respect to each other
5 for each layer of the laminate; the most common and easily
6 accessible graphite cloth available is produced having the 90
7 degree criss-cross formation, wherein the fibers 34 and 36 have an
8 under-over weave configuration (Fig. 4, shown grossly exaggerated).
9 Generally the thickness of a single ply of this cloth is 0.010".

10
11 The plies of the graphite cloth used in the laminate come
12 oriented in a particular direction. However, as the layers of
13 graphite cloth are built to form the laminated deck, the
14 orientations of each successive layer can be changed relative to
15 the prior layers. This common stacking sequence can be noted as 0,
16 90, +45, -45, 90, 0 for a 3 layer laminate, where one laminate
17 layer is defined as comprising 2 layers of fabric and one layer of
18 resin therebetween. In an embodiment of the present invention, by
19 using graphite cloth laminate that is interwoven, and yielding
20 fibers perpendicular to each other, using the most common stacking
21 sequence described above, this works out to be a three layer
22 laminate as defined above.

23
24 Embodiments of skateboard decks made using the process of the
25 present invention range in thickness from 14 - 26 layers, depending
26 upon the size and weight of the rider, as well as the type of
27 terrain, such as, but intended to be limited to, whether asphalt,
28 ceramic, concrete, desert, dirt, linoleum, tiles of all materials,
29 wood, or other surfaces, on which the skateboard will most often be
30 used. Consequently, skateboards made using the process of the
31 present invention are able to be used in a wide range of terrains,
32 and depending upon customer requirements, the process of the
33 present invention can be used make a custom skateboard for any ramp
34 (indoor or outdoor) and a different skateboard for use in, for

1 example only, and not intended as any limitation, a downhill or
2 slalom type of skateboard use.

3
4 A layer of fiberglass 50 may also be used in the manufacture
5 of these skateboard deck embodiments. Referring to Fig. 3, this
6 additional layer is formed by sandwiching the fiberglass 50 between
7 two layers of laminating resin 22a and 22b, and using the
8 fiberglass layer as the base layer onto which the remainder of the
9 skateboard deck is built. In so doing, the fiberglass layer
10 becomes the bottom surface of the finished deck. The fiberglass
11 layer provides a more finished appearance to the skateboard deck
12

13 Thermoforming Process for Graphite Skateboard Decks.

14

15 In addition to the hand layup process, embodiments of the
16 skateboard deck of the present invention may also be manufactured
17 using a thermoforming process. The thermoforming process can
18 employ a carbon fiber cloth known in the industry as a "pre-preg"
19 cloth. For purposes of this specification, "pre-preg" refers to
20 carbon fiber cloth which is supplied containing the resin already
21 in it; once the cloth is heated, the resin becomes activated and
22 binds the layers of cloth together. One example of a pre-preg
23 cloth is available from Revchem Plastics, Redlands, CA, and sold as
24 graphite or carbon fiber cloth.

25
26 A set of dies is manufactured, for use in a press type
27 operation. These dies are generally machined from metal, and will
28 not only form the skateboard decks but at the same time they will
29 allow for the outside edges of the deck to be trimmed once the dies
30 are brought together. The material used for the decks is multiple
31 layers of 0.015" thick sheets of pre-preg graphite cloth. The term
32 graphite can be interchanged with the term carbon fibre, as has
33 been described previously.
34

1 The process of thermoforming involves applying a vacuum in
2 conjunction with the application of heat to the materials. Applied
3 pressure during the operation is left minimal in respect to the
4 vacuum and applied heat. The vacuum is used to pull air out of the
5 mold and from in between the multiple layers of pre-preg cloth and
6 resin. Typically a vacuum ranging from approximately 20 psi to
7 approximately 50 psi is applied and maintained during the curing
8 process of each unit. The temperature range varies, ranging from
9 between approximately 200 degrees F to approximately 600 degrees F.
10 More commonly, a temperature range of between approximately 250
11 degrees F to approximately 300 degrees F is used, with
12 approximately 250 degrees F being the most commonly employed
13 temperature, thereby causing the resin contained within the pre-
14 preg cloth to exotherm, i.e., that the resin has started to flow
15 and react. The vacuum and temperature parameters must be adjusted
16 for atmospheric deviations that may occur throughout the curing
17 time. The curing time for the laminated skateboard decks could be
18 between approximately 1 hour to approximately 4 hours, depending
19 upon temperature, but generally the curing time is approximately
20 two and one half hours.

21
22 The fiber orientation in the pre-preg cloth most commonly sold
23 is of a 0, 90 configuration. In this configuration, such as shown
24 in Fig. 4, the fibers 34 and 36 run in the 0 direction and also in
25 the 90 direction, interweaving throughout the cloth at
26 approximately a 90 degree angle to each other. This common
27 orientation will be used, so as to minimize waste of cloth.
28 However, for custom applications, the fiber orientation may be
29 altered to as to produce stronger possible configurations. When
30 the fibers are oriented in for example only, a 0, 90, +45, -45, 90,
31 0 configuration, which in this instance represents a six-ply
32 laminate, the strongest possible configuration is established for
33 vertical loading. Skateboarding, however, uses more than just
34 vertical loading and for this unique application different laminate

1 configurations will need to be determined.

2
3 A layer of fiberglass 50 may also be used in the manufacture
4 of these skateboard deck embodiments. Referring to Fig. 3, this
5 additional layer is formed by sandwiching the fiberglass 50 between
6 two layers of laminating resin 22a and 22b, and using the
7 fiberglass layer as the base layer onto which the remainder of the
8 skateboard deck is built. In so doing, the fiberglass layer
9 becomes the bottom surface of the finished deck. The fiberglass
10 layer provides a more finished appearance to the skateboard deck
11

12 To determining the various strengths of the carbon fiber
13 laminate skateboard deck we have used classical lamination theory
14 in conjunction with the Tsai Hill failure criteria (Gibson, Ronald
15 F., 1994, Principles of Composite Material Mechanics, pp. 101-106,
16 McGraw-Hill Science, New York, NY). The values shown below were
17 determined using Tsai Hill lamination theory, but which equation is
18 not shown because of its complexity. Shown below are equations
19 based on using a singularity function.
20

Graphite Skateboard Flex Test

In order to calculate the deflection of the skateboard deck certain measurements must be made from the deck itself.

L= Length between trucks	L=21 in,
W= Width of deck	W= 7 in.
T= Thickness of deck	T= .22 in.

For these calculations, one treats the skateboard as a simply supported beam with two vertical supports. The average weight of a person, assumed to be 200 pounds, riding the skateboard is assumed to be centered between the trucks, thereby simulating the maximum deflection undergone by the skateboard. In this case, the governing equation can be written as such:

$$\delta = \frac{F}{E \cdot I} \left[\frac{(L - a)^3}{L} \cdot [L^2 - (L - \text{position})^2] \cdot \text{position} - \left(\frac{L - \text{position}}{\text{position}} \right) \text{position}^3 \right]$$

F= Average weight of rider	F=200 pounds
E= Modulus of Elasticity of Graphite Laminate	E=40 x 10 ⁶ psi
I= Moment of Inertia of Deck Cross Section	$I = \frac{bT^3}{12}$

Position of Rider Between Trucks	Position= L/2
----------------------------------	---------------

By using a singularity function to describe the deflection of the skateboard deck between the trucks, the maximum deflection occurs at exactly half way between the trucks. The corresponding deflection for this point along the skateboard is:

$$\delta = 0.466 \text{ in.}$$

1 To determine the maximum bending stress of the skateboard
2 deck, the force will also be applied exactly halfway in between the
3 trucks, and the governing equation is:

$$\sigma = \frac{My}{I}$$

7 First the bending moment must be determined:

$$M = F(\text{Position})$$

$$M = 2100 \text{ lbf}\cdot\text{in}$$

11 Next the centroid is calculated. In the example illustrated
12 herein, assuming that the skateboard deck is relatively
13 rectangular, the governing equation is merely:

$$y = T/2$$

17 After calculating the bending moment and the centroid, the maximum
18 binding stress is computed by the equation:

$$\sigma = \frac{My}{I}$$

$$\sigma = 37190 \text{ psi}$$

23 If the yield stress of a graphite/epoxy laminate is known to be
24 65,000 psi, one can make the assumption that the calculated bending
25 stress (37190 psi) is thus well within the yield limits for the
26 given material.

28 The skateboard deck of the present invention, made from a
29 laminate of carbon fiber layers, has a greater amount of flex than
30 skateboard decks made from wood, and its' strength is comparable to
31 that of wooden skateboard decks. The skateboard decks of the
32 present invention are very durable, unlike wooden skateboard decks
33 which frequently break during use. The performance of the
34 skateboard decks of the present invention also differs from that of
35 wooden skateboard decks, such that they do not slide when one is

1 taking corners, as they create a greater downward force when
2 cornering thereby minimizing the sideward forces that would cause
3 sliding on corners.
4

5 Therefore, although this invention has been described with a
6 certain degree of particularity, it is to be understood that the
7 present disclosure has been made only by way of illustration, and
8 that numerous changes in the details of construction and
9 arrangement of parts may be resorted to without departing from the
10 spirit and scope of the invention.